San Joaquin River Organophosphorus (OP) Pesticides TMDL Workshop

DRAFT NUMERIC TARGET

California Regional Water Quality Control Board, Central Valley Region

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Workshop Agenda

- Overview of Components of TMDL
- Central Valley Regional Water Quality Control Board – San Joaquin River

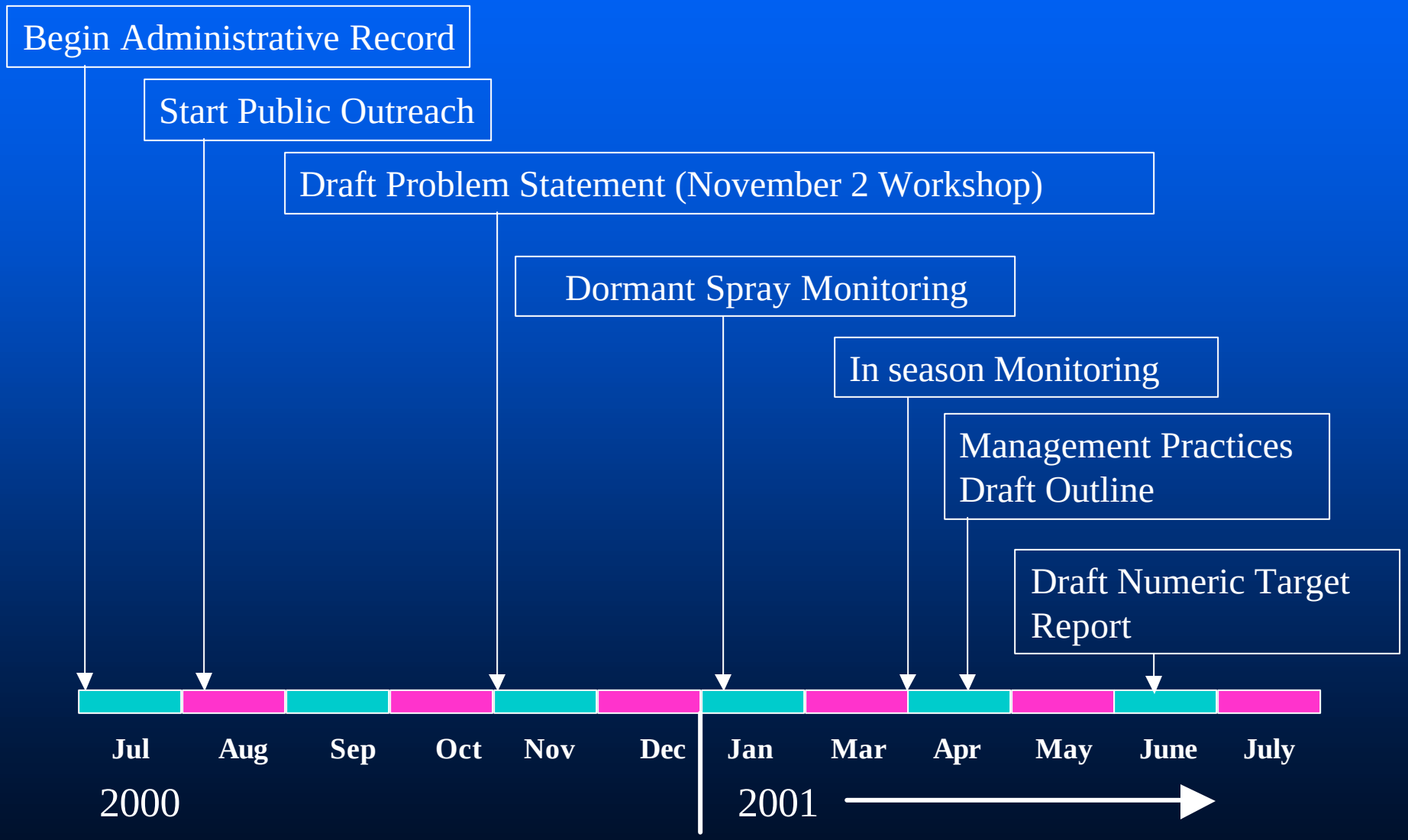
  OP Pesticide TMDL Timelines
- OP Pesticides Numeric Target Analysis

Components of TMDL

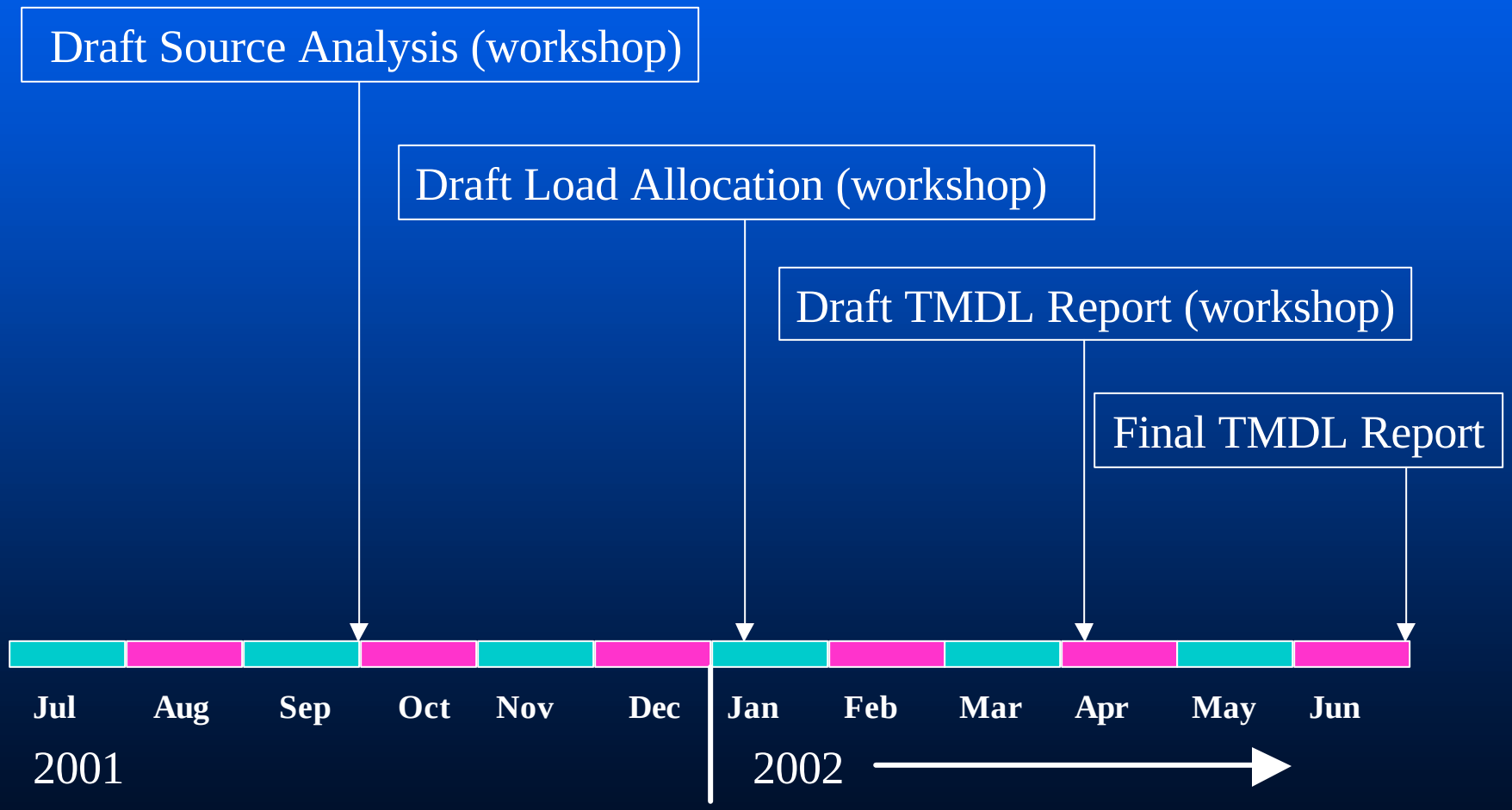
- TMDL Description (Problem Statement)
- Numeric Target
- Source Analysis
- Load Allocation
- Linkage Analysis
- TMDL REPORT
- *Basin Plan Amendment*

  (Water Quality Objectives & Implementation Plan)
- *Ongoing Monitoring*

SJR OP Pesticide TMDL Timeline
July 2000 to July 2001



SJR OP Pesticide TMDL Timeline
July 2001 to June 2002



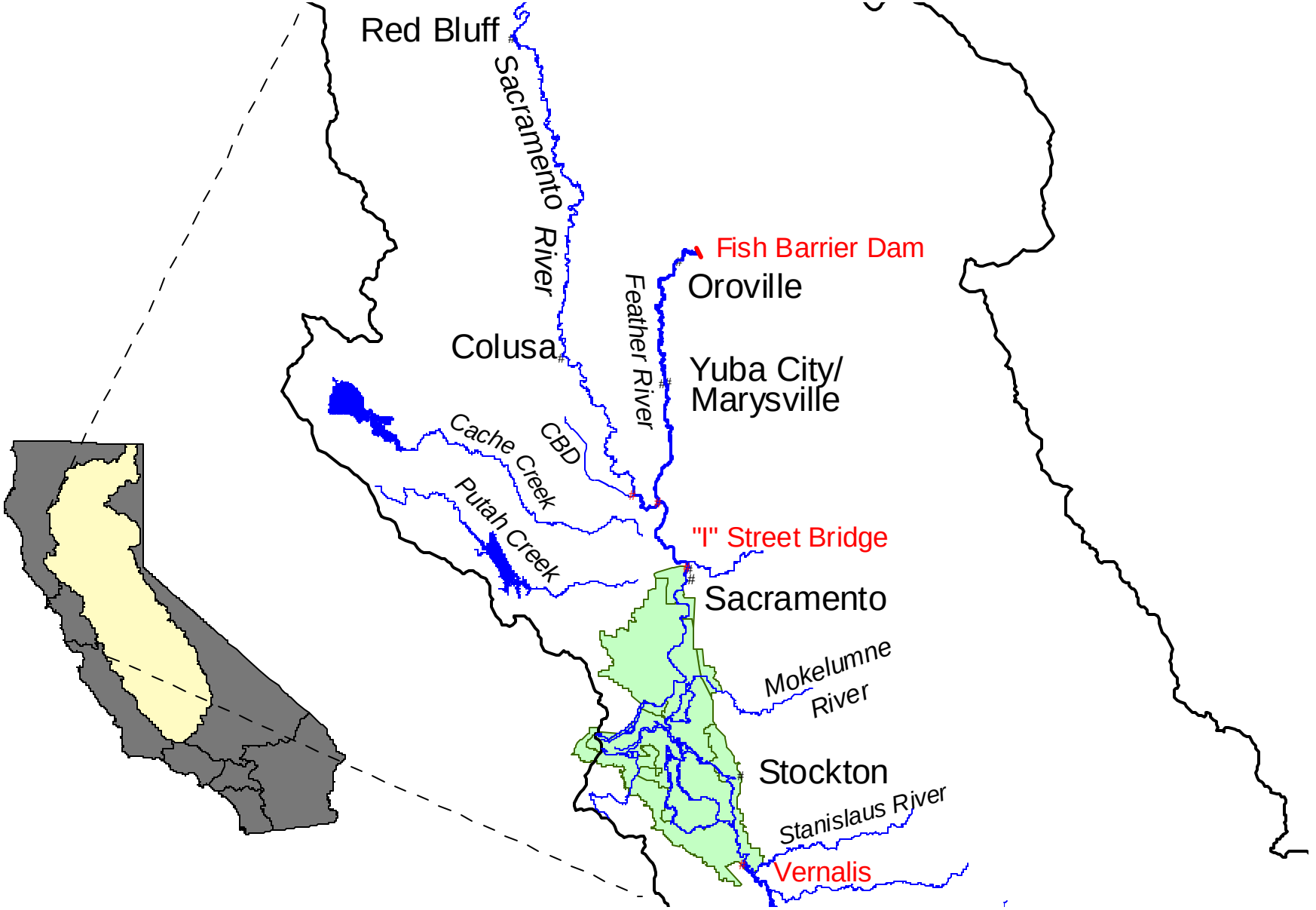
OP Pesticide TMDL

Numeric Target Analysis

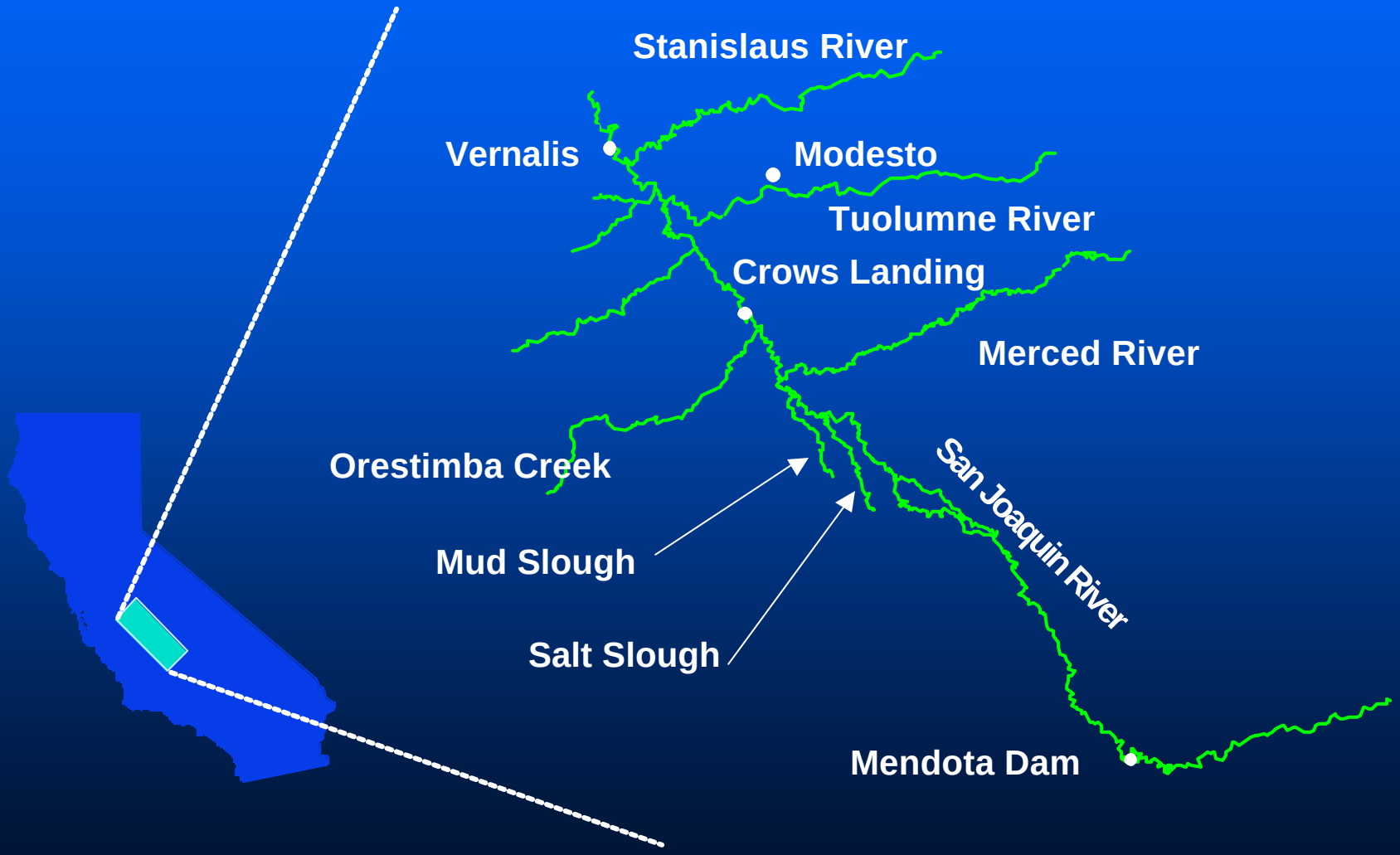
Geographic Area Where Target Apply

- The Lower Sacramento River
- The Lower Feather River
- The Lower San Joaquin River
- The Sacramento-San Joaquin River Delta

Project Area Where Numeric Target Is Applied



Project Area Where Numeric Target is Applied



Beneficial Uses

Sacramento River	Lower Feather River	San Joaquin River	Sacramento-San Joaquin Delta
municipal and domestic supply, agricultural supply, industrial service supply, water-contact and non-water-contact recreation, freshwater habitat, fish migration, fish spawning, wildlife habitat and navigation	municipal and domestic supply, agricultural supply, water- contact recreation, canoeing and other non-water-contact recreation, freshwater habitat, fish migration, fish spawning and wildlife habitat	municipal and domestic supply, agricultural supply, industrial process and service supply, water- contact recreation, canoeing and other non-water-contact recreation, freshwater habitat, fish migration, fish spawning and wildlife habitat	municipal and domestic supply, agricultural supply, industrial process and service supply, water-contact and non-water-contact recreation, freshwater habitat, fish migration, warm water fish spawning, wildlife habitat and navigation

Regulatory Background

- Federal Clean Water Act
- Porter-Cologne Water Quality Act
- Basin Plans- Water Quality Control Plans

Water Quality Objectives

- Narrative Water Quality Objective
- Anti-Degradation Policy
- Numeric Water Quality Objective
- Water Quality Objectives vs. Numeric Targets

Toxicology of Diazinon and Chlorpyrifos

- Organophosphorus insecticides
- Mode of action: cholinesterase inhibition
- Result: respiratory paralysis
- Bioaccumulation: not primary concern

Aquatic Toxicity

- Acute: short-term exposure, EC50, LC50
- Chronic: one or more generations,
  effects on growth or reproduction
- MATC, NOEC, LOEC, ng/L = ppt
- Aquatic insects, crustaceans very sensitive
- Aquatic plants, adult fish not very sensitive
- Freshwater crustacean, *Ceriodaphnia dubia*, commonly used for toxicity testing

Additive Toxicity

- Similar modes of action and toxicological effects = likely additive toxicity
- Studies on *C. dubia* indicate additivity
- Diazinon, chlorpyrifos have been detected together in agricultural and urban runoff

Methods Considered for Deriving Numeric Targets

- Based on Anti-degradation Policy
- USEPA Method for Deriving Water Quality Criteria (as applied by EPA)
- USEPA Method for Deriving Water Quality Criteria (as applied by CDFG)
- Probabilistic Ecological Risk Assessment (PERA)
- Microcosm/Mesocosm Studies
- Literature findings, listed species

Anti-degradation Policy

- Maintain pollutant levels at “background”
- “Background” is zero for most pesticides
- Exception: if Regional Board finds degradation to be in State’s best interest
  - Beneficial Uses must still be protected
  - Exception must be consistent with other policies

USEPA Method
As Applied by EPA

- Guidelines published in 1985
- WQC intended to protect all tested species, species for which tested spp are surrogates
- WQC designed to provide “reasonable level of protection” and prevent “unacceptable impacts”

EPA Method (Cont'd)

- Two values are derived:
- Criterion Maximum Concentration (CMC)

  - acute criterion, one hour avg, every 3 yrs
- Criterion Continuous Concentration (CCC)

  - chronic criterion, four day avg, every 3 yrs

EPA Method (Cont'd)

- Data must be available for eight families:
- A salmonid (salmon, trout)
- Another fish family (bluegill, catfish, etc)
- A third vertebrate family (fish, amphibian)
- A planktonic crustacean (daphnid, copepod)
- A benthic crustacean (crayfish)
- An aquatic insect
- A non-arthropod, non-vertebrate (mollusk)
- Another family not already represented

EPA Criteria for Diazinon

- EPA published draft criteria in 1998
- 12 invertebrates, 10 fish species
- CMC: 90 ng/L (draft)
- CCC: none calculated, ACRs widely varied
- New criteria document currently in prep

EPA Criteria for Chlorpyrifos

- Published in 1986
- 11 invertebrates, 7 fish species
- CMC: 83 ng/L
- CCC: 41 ng/L

California Department of Fish and Game Criteria for Diazinon

- Published in 2000
- 9 invertebrates, 9 fish species
- CMC: 80 ng/L
- CCC: 50 ng/L

CDFG Criteria for Chlorpyrifos

- Published in 2000
- 13 invertebrates, 7 fish species
- CMC: 25 ng/L
- CCC: 14 ng/L

Probabilistic Ecological Risk Assessment (PERA)

- PERA based on:
  - distributions of concentrations in water
  - vs. distributions of toxicologic values
  - Distribution of concentrations indicates
    probability of exceeding specific conc
  - Distribution of toxicity data indicates
    probability exceeding specific tox value
  - Degree of overlap indicates
    joint probability of exposure and toxicity

PERA (Cont'd)

- "Criterion of Management":

  - percent of species for which toxic effect considered acceptable

- LC50 values used because most available, increases confidence in distribution

PERA for Diazinon in Sacramento-San Joaquin

- Conducted by Novartis in 1997
- Used acute toxicity data from three sources:
  - EPA pesticide toxicity database
  - EPA AQUIRE database
  - CDFG hazard assessment
- Included toxicity data for 63 species
  - about half were crustaceans or insects

Novartis PERA (Cont'd)

- Used concentration data from USGS, Regional Board, DPR
- Sites monitored included:
- agriculturally dominated creeks
- irrigation channels
- mainstem rivers
- Data from 1991 to 1994

Novartis PERA (Cont'd)

- 5^{th} centile for arthropods: 195 ng/L
- 10^{th} centile for arthropods: 483 ng/L
- 5^{th} centile for all species: 1,117 ng/L
- 10^{th} centile for all species: 3,710 ng/L

Novartis PERA Conclusions: Individual Effects

- Adult fish at low risk
- Sensitive arthropods in mainstem occasionally exposed to toxic levels
- Sensitive arthropods in agricultural drains at greatest risk, especially in Jan/Feb (dormant spray season)

Novartis PERA
Conclusions – Ecological Effects

- Cladocerans at greatest risk, but
- Cladocerans not primary food for fish
- No direct ecological risk to fish populations,
  unless crustaceans, insects also
  reduced during critical feeding periods

Microcosm/Mesocosm Studies

- Small or medium-scale chambers to study chemical fate and effects
- Contain assemblage of organisms
- Processes, exposure, effects more similar to natural environment than single-spp tests

Application of Microcosms/Mesocosms

- Diazinon studied in outdoor micro/ mesocosms to determine exposure/effects relationship (Giddings et al. 1992, 1996)
- Exposures ranged from 2,300-443,000 ng/L
- Endpoints measured:

- Abundance of zooplankton, benthics, fish
- Fish reproduction, growth, survival

Mico/mesocosm Results

- Cladoceran populations severely reduced; some insects affected at 2,000 ng/L

  - 2,000 was lowest conc measured

- Fish biomass reduced at 45,000 ng/L

Micro/mesocosms Conclusions – Ecological Effects

- Overall structure, function of micro/meso "ecosystem" not affected 2,000-5,000 ng/L
- "Ecosystem" LOAEC was 8,400-9,100
- LOAEC: effects on major invertebrates

Literature Findings
Listed Species

- Target could also be derived from:

  - new studies in scientific journals, e.g.,

    recent findings on diazinon effects on salmon olfactory function

  - concerns regarding threatened or endangered species

Criteria for Evaluating Methods for Deriving Numeric Targets

- Method must result in numeric targets that:
- protect designated Beneficial Uses
- are consistent with State and Federal regulations and policies
- are acceptable to SWRCB and EPA

Based on Anti-degradation - Advantages and Disadvantages

- Most protective of Beneficial Uses
- Consistent with State and Federal policies

- May be difficult to achieve
- May be unnecessarily protective

EPA Method as Applied by EPA and CDFG - Advantages

- Acute and chronic toxicity data used
- Consistent with State and Federal regs and Basin Plan provisions
- Approved by EPA for WQC nationwide
- Supported by CDFG for hazard assessment of pesticides in Sacto-SJ River system

EPA Method as Applied by EPA and CDFG - Disadvantages

- One sensitive sp has disproportionate effect
- Does not necessarily account for behavioral effects, e.g., recent salmon findings (Scholz et al., 2000)

PERA Method as Applied - Advantages

- Allows direct comparison of risk management assumptions to probability of exceedences in the environment
- Method similar to current risk assessment methods applied to other environmental media

PERA Method as Applied – Disadvantages

- Method based on LC50 values;

  - already represents 50% mortality of individuals
- No basis provided for premise that individual or species loss is not ecosystem impact
- Method not consistent with Basin Plan

  narrative objective of no toxicity
- Method still under development;

  not currently used to develop WQC

Micro/Mesocosms - Advantages

- Species assemblage more realistic than single-sp lab tests used by EPA and PERA
- More realistic exposure regimes because allow partitioning water:sediment
- Can incorporate potential indirect ecological impacts of toxicants
- Can allow for ecological recovery from chemical stress

Micro/mesocosms - Disadvantages

- Environmental chemistry/exposure not necessarily the same as actual environmental conditions
- Micro/mesocosm studies did not report NOEC; not possible to calculate MATC
- Basis for concept that some taxa not ecologically important not provided
- Premise that some species don’t need protection not consistent with Basin Plan narrative objectives

Summary of Potential Targets

Method	Diazinon (ng/L)		Chlorpyrifos ng/L)	
	Acute	Chronic	Acute	Chronic
Based on Strict Interpretation of Anti-Degradation Policy	0	0	0	0
US EPA Method as Used by US EPA	90	NA	83	41
US EPA Method as Used by CDFA	80	50	25	14
PERA Method	195 (5^{th} centile), 483 (10^{th} centile) (arthropod only)		NA	
Microcosm/ mesocosm "ecosystem LOEC	9,100 (microcosm) 8,400 (mesocosm)		NA	
Microcosm/mesocosm Cladoceran LOEC	<2,300		NA	

Recommended Target

- The numeric target selected by the Regional Board will be adopted as a water quality objective
- The recommended target must therefore comply with evaluation criteria…

Recommended Target Evaluation Criteria

- protect beneficial uses, including preservation or enhancement of aquatic habitat, including invertebrates
- be consistent with the interpretation of beneficial use protection contained in the existing narrative toxicity and pesticide objectives, i.e., does not allow detrimental physiological responses in aquatic life
- be consistent with Federal regulations, including requirements for establishment of water quality criteria

Additional Requirements to be Adopted as a Water Quality Objective

- The selected method must be consistent with State policy to be acceptable to:
  - SWRCB
  - Office of Administrative Law
  - U.S. EPA

all must ultimately approve the water quality objective

Summary of Methods

- CDFG application of EPA method appears to be most appropriate for protection of beneficial uses
- PERA could be modified to be more consistent with beneficial use protection; for example:
  - apply safety factor for chronic effects, and/or
  - use lower centile for risk management

Recommended Target

U.S. EPA Method as Used by CDFA

Diazinon (ng/L)		Chlorpyrifos ng/L)	
Acute	Chronic	Acute	Chronic
80	50	25	14

Other Considerations

- Establishment of the final numeric targets and water quality objectives will also depend on the evaluation of:
  - environmental characteristics of the watershed
  - water quality conditions that could be reasonably achieved through the coordinated control of all factors which affect water quality in the area
  - economic considerations
  - the need for developing housing in the region
  - the need to develop and use recycled water

(Required under section 13241 of Porter-Cologne Water Quality Act)

Other Considerations (continued)

- Establishment of the final numeric targets and water quality objectives will also depend on the evaluation of:
  - future scientific findings on aquatic toxicity
  - Endangered Species Act
- Application of target and water quality objectives must also account for additivity

Conclusions

- Available information has been summarized in a draft target analysis report
- Targets selected for this TMDL will be proposed as new water quality objectives as part of the TMDL implementation process
- Targets will apply only in main stem rivers and main channels of the Delta
- Targets will be used by staff to develop other TMDL elements (e.g., load allocations)

What's Next?

- Staff is interested in your comments/questions on this target analysis
- Comments will be considered in development of the final technical TMDL report
- There will be further opportunity to formally comment on these or revised numbers during the Basin Plan Amendment process
- Regional Board staff will move forward with other TMDL elements